SECTION III

AFFECTED ENVIRONMENT

3.1 EARTH

This section describes the existing soil and geologic conditions. Information in this section was gathered from the following sources:

- Preliminary Engineering Geologic and Geotechnical Engineering Services report for Park Lake Homes Redevelopment.[1]
- Soil Survey of King County area, Washington.[2]
- Geologic map of surficial deposits in the Seattle 30' x 60' quadrangle, Washington.[3]
- Duwamish Basin Groundwater Pathways Conceptual Model Report.[4]
- King County Sensitive Areas Map Folio.[5]
- King County Code Title 21A, Zoning.[6]
- Major Geologic Structural Feature Locations in the Project Vicinity, prepared for the Brightwater Draft EIS.[7]
- Lifelines and earthquake hazards in the greater Seattle area (map).[8]
- Abrupt uplift within the past 1700 years at southern Puget Sound, Washington.[9]
- Landslides caused by earthquakes.[10]

3.1.1 Affected Environment

Topography and Vegetation

The project site is located along the eastern portion of an upland plateau, between West Seattle and Burien. The existing developed portions of the site are located at the top of the plateau with two north-south trending ridges. The western on-site ridge is centered about 9th Place Southwest and has a maximum elevation of approximately 445 feet. The Eastern on-site ridge is centered about 6th Place Southwest and has a maximum elevation of about 440 feet. The north-south trending topographic trough located between the two ridges has a minimum elevation of approximately 410 feet. The west side of the western ridge slopes downward to an elevation of about 375 feet at the western site boundary, along 12th Avenue Southwest. The east-side of the eastern ridge slopes downward to an elevation of approximately 375 feet at the eastern site boundary, just east of Southwest 97th Place and 3rd Avenue Southwest.

An existing piped inflow and outflow is located in the easternmost portion of the site, between Southwest 97th Place and Southwest 98th Place. This swale slopes downward toward the east with a minimum elevation of approximately 300 feet at the eastern site boundary.

Vegetation within the developed portions of the site consists primarily of grass lawns with landscaped shrubs and trees. The undeveloped drainage swale located in the eastern portion of the site is a lightly forested area with second growth conifers and various deciduous species.

1 GeoEngineers, 2003
2 U.S. Department of Agriculture, Soil Conservation Service, 1973
3 U.S. Geological Survey, 1993
4 Booth & Herman, 1998
5 King County, 1990a
6 King County, 1998 and 1993
7 HWA GeoSciences & Shannon & Wilson, 2002
8 U.S. Geological Survey, 2002
9 Science, 1992
10 Geological Society of America Bulletin, 1984

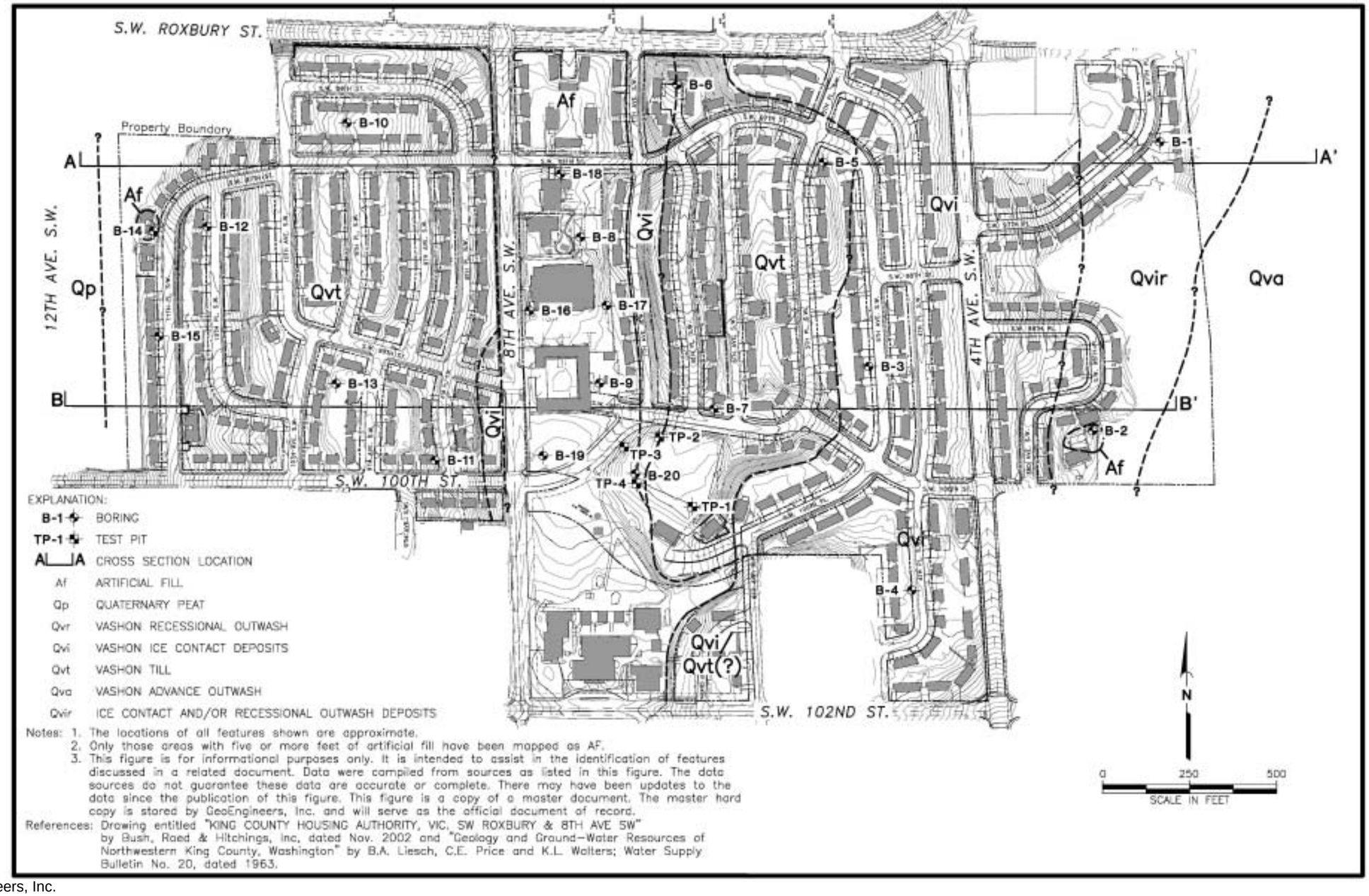
Undergrowth in this area includes salmonberry, sword fern, blackberry, grass, and other species typical of forested areas in the Puget Sound region.

Soils and Geology

Soils of the upland plateau in site vicinity are generally classified as part of the Alderwood Association, which is characterized by moderately well drained, undulating to hilly soils underlain by very slowly permeable glacial till. This soil classification is consistent with the mapped surficial geology of the site vicinity, which indicates that till and recessional outwash are present at the site.

Figure 3.1-1 is a surficial geologic map of the site based on 20 exploration borings and four test pits. **Table 3.1-1** presents a summary of the on-site explorations.

The map identifies six primary units: 1) Fill (Af), 2) Peat (Qp), 3) Vashon ice contact deposits (Qvi), 4) Vashon ice contact and/or recessional outwash deposits (Qvir), 5) Vashon till (Qvt), and 6) Vashon advance outwash (Qva). The Qvi, Qvir, Qvt and Qva units were deposited during the most recent glaciation of the region, which occurred 13,000 to 15,000 years ago, and is known as the Vashon stade of the Frasier glaciation. Peat was deposited within an off-site closed depression during post-Vashon time. Recently placed fill (artificially placed soil) is present over the glacial deposits at several locations throughout the site. The interpretation of subsurface geologic conditions is shown in the geologic cross sections (see **Figures 3.1-2** and **3.1-3**). The locations of the cross sections are shown in Figure 3.1-1.



EXPLANATION:

B-1	BORING
TP-1	TEST PIT
A|__|A	CROSS SECTION LOCATION
Af	ARTIFICIAL FILL
Qp	QUATERNARY PEAT
Qvr	VASHON RECESSIONAL OUTWASH
Qvi	VASHON ICE CONTACT DEPOSITS
Qvt	VASHON TILL
Qva	VASHON ADVANCE OUTWASH
Qvir	ICE CONTACT AND/OR RECESSIONAL OUTWASH DEPOSITS

Notes:
1. The locations of all features shown are approximate.
2. Only those areas with five or more feet of artificial fill have been mapped as AF.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

References: Drawing entitled "KING COUNTY HOUSING AUTHORITY, VIC. SW ROXBURY & 8TH AVE SW" by Bush, Raed & Hitchings, Inc, dated Nov. 2002 and "Geology and Ground-Water Resources of Northwestern King County, Washington" by B.A. Liesch, C.E. Price and K.L. Walters; Water Supply Bulletin No. 20, dated 1963.

Source: GeoEngineers, Inc.

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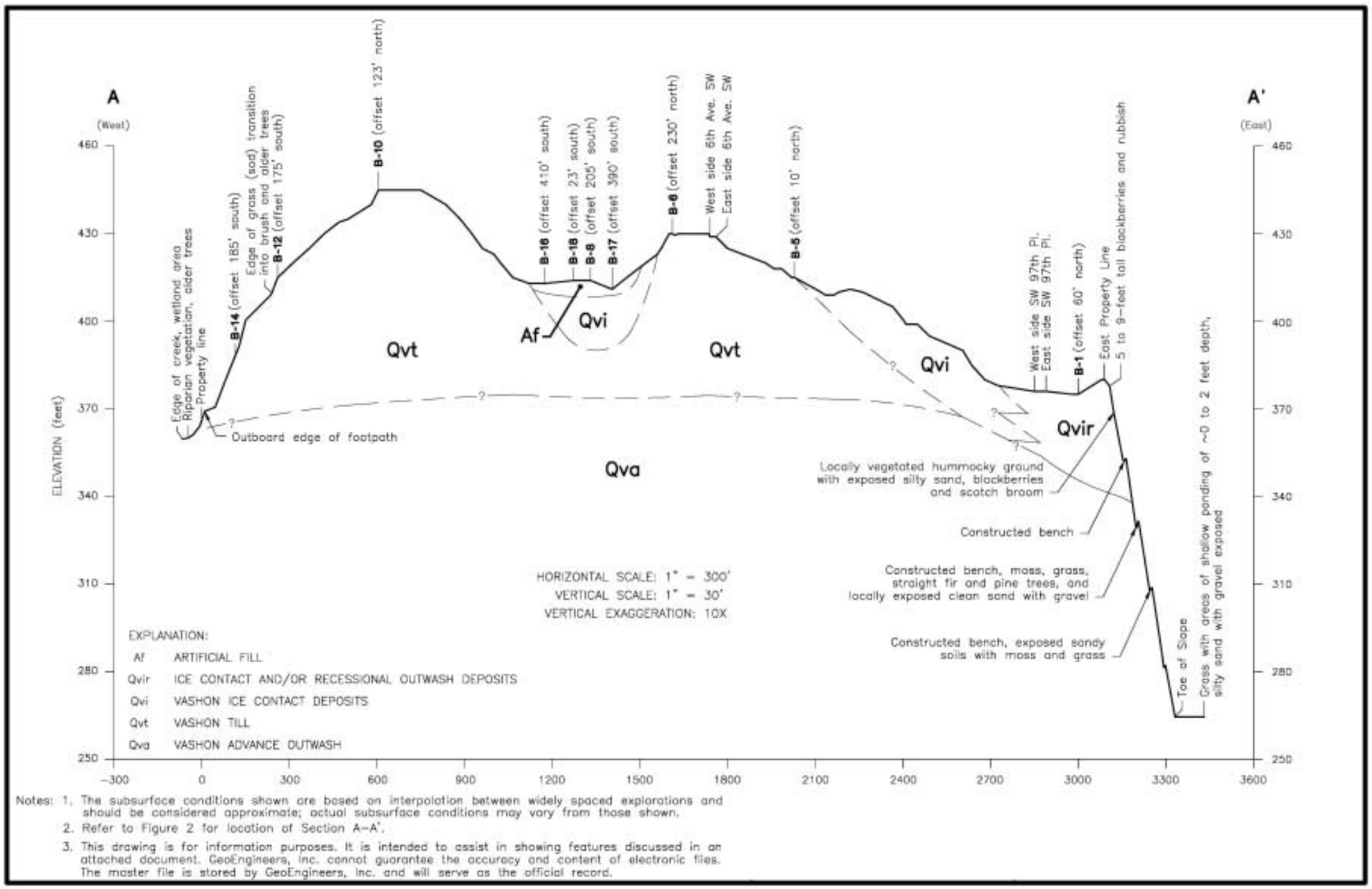
Figure 3.1-1

Surficial Geology Map



Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 2 for location of Section A-A'.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record.

Source: GeoEngineers, Inc.

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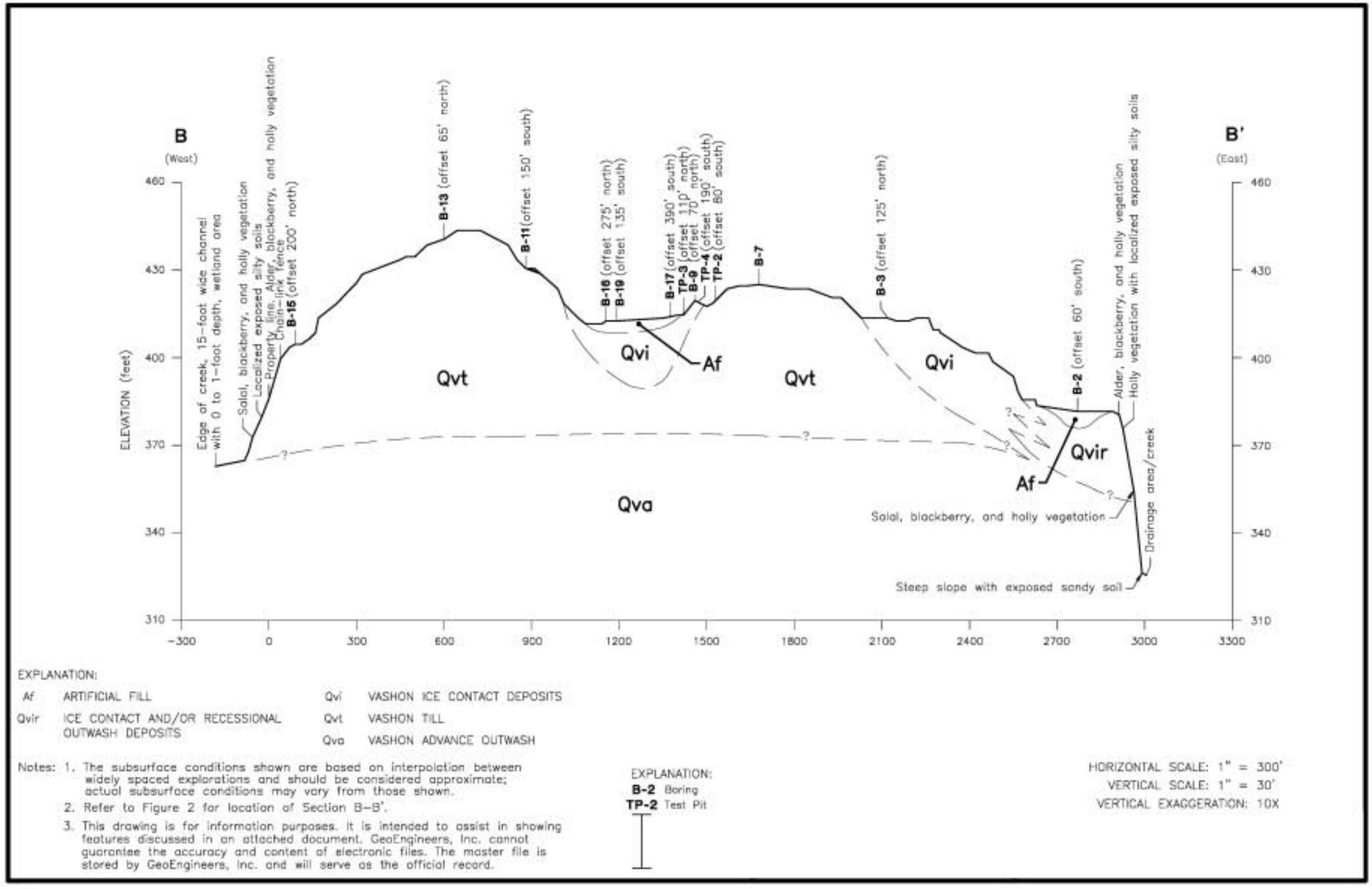
Figure 3.1-2

Cross Section A



EXPLANATION:

Af	ARTIFICIAL FILL	Qvi	VASHON ICE CONTACT DEPOSITS
Qvir	ICE CONTACT AND/OR RECESSIONAL OUTWASH DEPOSITS	Qvt	VASHON TILL
		Qva	VASHON ADVANCE OUTWASH

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 2 for location of Section B–B'.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record.

EXPLANATION:
B-2 Boring
TP-2 Test Pit

HORIZONTAL SCALE: 1" = 300'
VERTICAL SCALE: 1" = 30'
VERTICAL EXAGGERATION: 10X

Source: GeoEngineers, Inc.

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Figure 3.1-3

Cross Section B

Table 3.1-1
SUMMARY OF EXPLORATION BORINGS AND TEST PITS

Boring/ test pit	Address	Depth (ft.)	Observation well? (y/n)
B-1	9620 – 2nd Ave. S.W.	75	N
B-2	9838 – 3rd Ave. S.W.	50	N
B-3	9811 – 5th Ave. S.W.	15	Y (Wet)
B-4	10030 – 4th Pl. S.W.	15	N
B-5	9702 – 5th Pl. S.W.	25	Y
B-6	9603 – 6th Pl. S.W.	25	N
B-7	9834 – 6th Pl. S.W.	25	N
B-8	9700 – 8th Ave. S.W. (NE Parking lot)	25	N
B-9	9900 – 8th Ave. S.W. (East side maintenance building)	25	Y
B-10	920 – S.W. 97th Street	25	N
B-11	822 – S.W. 100th St.	25	Y
B-12	9715 – 10th Pl. S.W.	15	N
B-13	9915 – 9th Ave. S.W.	15	N
B-14	9719 – 11th Ave. S.W.	25	N
B-15	9905 – 11th Ave. S.W.	75	Y
B-16	9800 – 8th Avenue S.W. (SW Corner of Community Center)	25	N
B-17	9800 – 8th Avenue S.W. (SE Corner of Community Center)	30	N
B-18	9700 – 8th Avenue S.W. (N. side of Head Start & Food bank)	25	N
B-19	9900 – 8th Avenue S.W. (South end ballfield)	20	N
B-20	700 block – S.W. 100th Street	12	N/A
TP-1	700 block – S.W. 100th Street	12	N/A
TP-2	700 block – S.W. 100th Street	12	N/A
TP-3	700 block – S.W. 100th Street	11.5	N/A
TP-4	700 block – S.W. 100th Street	12	N/A

The most extensive on-site fill (Af) is located within the north-south trending topographic trough, between 8th Avenue Southwest and 7th Avenue Southwest (see Figures 3.1-2 and 3.1-3). Fill within this trough generally consists of 4 to 10 feet of loose to soft silty sand and sandy silt, with variable amounts of gravel and occasional debris (concrete, asphalt, glass, domestic rubbish). Another on-site area with fill is located near 3rd Avenue Southwest, where an 18-foot thick layer of loose to medium stiff silty sand and sandy silt was encountered in one of the on-site

exploration borings. It was not possible to determine the extent of fill in this area due to the development density. It is likely limited based on the condition of the nearby structures.

Vashon ice contact deposits (Qvi) at the site generally consist of a medium dense to dense mixture of silt and sand that is commonly stratified. These sediments were deposited by meltwater on or adjacent to glacial ice. Vashon ice contact deposits are mapped within the central and eastern portions of the site and underlie the fill located within the north-south trending topographic trough. The on-site Vashon ice contact deposits are interpreted to have a maximum thickness of approximately 20 to 30 feet.

Vashon ice contact/recessional outwash deposits (Qvir) at the site are similar to Qvi, but may also include variable amounts of gravel. These sediments were deposited by meltwater on or adjacent to glacial ice, or by meltwater streams from the retreating ice during the later part of the Vashon stade. Qvir is mapped in the easternmost portion of the site, where it is interpreted to underlie and interfinger with Qvi (see Figures 3.1-2 and 3.1-3). The base of Qvir beneath the eastern portion of the site is interpreted to occur at an approximate elevation of 320 to 350 feet, where it is underlain by Vashon till or Vashon advance outwash.

Vashon till (Qvt) at the site generally consists of a very dense mixture of gray sand, silt and gravel that was deposited at the base of the glacier and overridden by thousands of feet of ice. Vashon till is mapped within the western and central portions of the site. Beneath the western and central portions of the site, the base of the Vashon till unit is interpreted to occur at an approximate elevation of 360 to 370 feet, where it is underlain by Vashon advance outwash (see Figures 3.1-2 and 3.1-3).

Vashon advance outwash (Qva) beneath the site generally consists of very dense sand with variable amounts of gravel and occasional layers of silty sand. These sediments were deposited by streams from the advancing ice sheet during the early part of the Vashon stade, Vashon advance outwash is not exposed at the surface within the site boundaries, but it was encountered in the two deepest on-site borings, and is exposed along parts of the Duwamish Valley to the east (see Figures 3.1-1 through 3.1-3). Vashon advance outwash is interpreted to underlie the entire site below an approximate elevation of 360 to 370 feet.

Transitional beds consisting primarily of laminated silt and clay are interpreted to underlie the Vashon advance outwash below an approximate elevation of 200 feet. The transitional beds were deposited by impounded lakes that formed during the onset of the Vashon stade, prior to the advance of the ice sheet. The transitional beds were not encountered in any of the on-site borings.

Regional geologic maps and cross sections indicate that the transitional beds are underlain by a sequence of older (pre-Vashon) glacial and interglacial deposits that extend to an inferred elevation of approximately –300 feet in the site vicinity. These older glacial and interglacial deposits are underlain by marine and/or continental sedimentary bedrock that was deposited between about 10 and 40 million years ago (during the Tertiary period). Bedrock is inferred below an elevation of about –300 feet in the site vicinity.

Geologic Hazards

Erosion Hazards

Erosion of soils is a natural, ongoing physical process by which sediment is removed from topographic high points and transported downgradient by a variety of geomorphic processes. The erosional processes most commonly encountered within and adjacent to the site include soil creep and sheet wash, slope ravel, rill and gully erosion, and landsliding.

In general, all soils on slopes steeper than 40 percent have high erosion potential. Soils on slopes inclined between 15 and 40 percent may have medium or high erosion potential depending on the character of the soils; non-cohesive granular soils carry a higher erosion potential than more cohesive soils.

Figure 3.1-4 identifies areas susceptible to erosion mapped on and adjacent to the site. None of these on-site erosion areas are identified in the King County Sensitive Areas Map Folio.

Steep Slope Hazards

Steep slope hazard areas are defined as those areas 40 percent or steeper with a vertical change of at least 10 feet. Steep slopes over 20 feet in vertical height are more severely regulated than those less than 20 feet in vertical height. In addition, a steep slope has been created east of the northeast property line during previous aggregate mining activities.

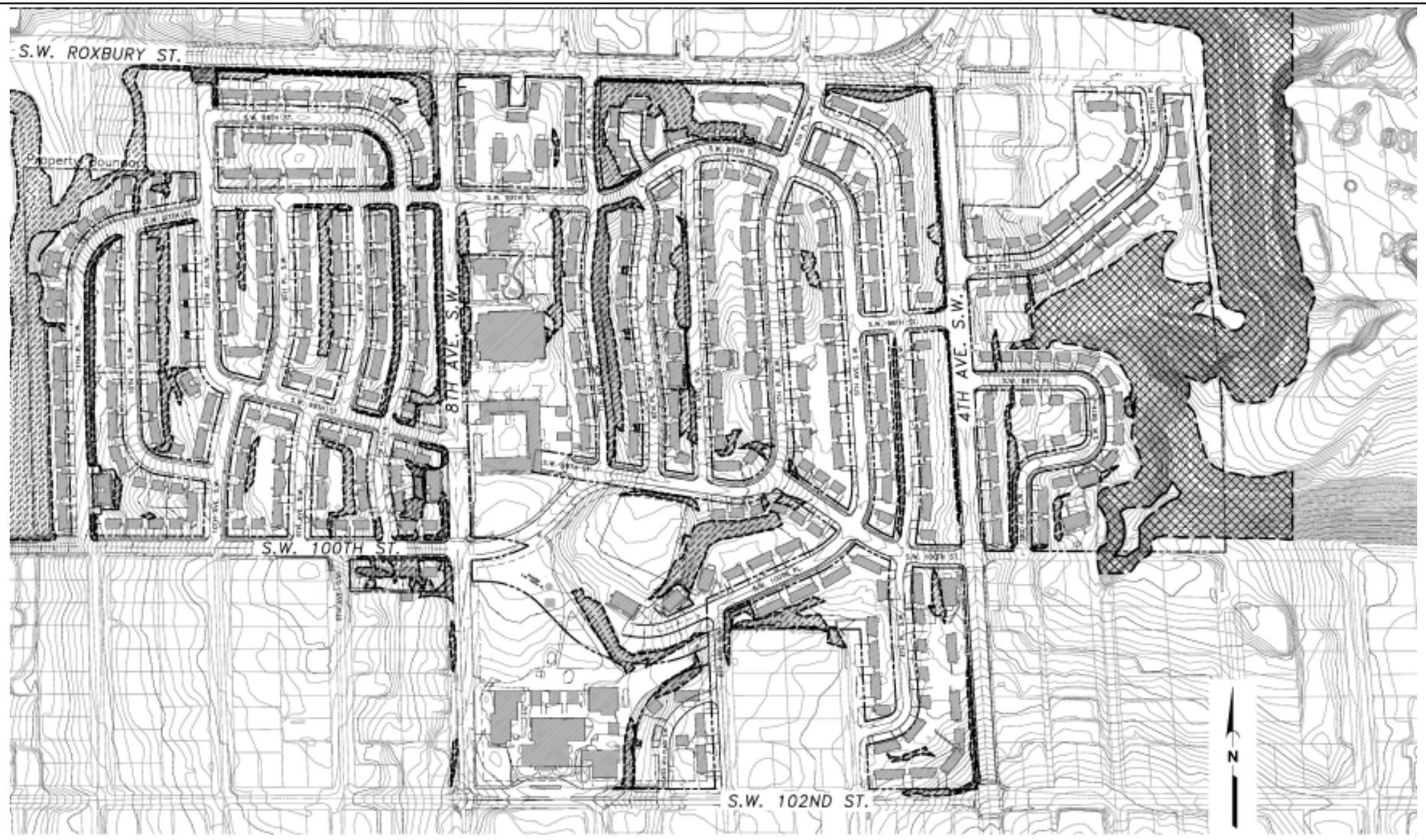
Figure 3.1-5 identifies the steep slope hazard area mapped on the project site. With the exception of the existing piped inflow and outflow located in the easternmost portion of the project site, none of the on-site slopes that are 40 percent or steeper exceed the vertical change criterion of 10 feet.

Landslide Hazards

Landsliding is the slow to rapid, downslope mass movement of soil and vegetative cover. The failures may occur as planar slides, block slides, rotational slumps, debris avalanches and mudflows. Landsliding usually occurs on steep slopes and is commonly initiated during periods of intense rainfall when the water table is high.

Landslide hazard areas are defined as (1) any areas with slopes greater than 15 percent that are underlain by impermeable soils and that include springs or groundwater seepage, (2) landslides that have moved during the last 10,000 years, (3) areas "potentially unstable as a result of rapid stream incision or undercutting by wave action," (4) areas showing "evidence of or is at risk from avalanches," or (5) areas located on alluvial fans that are "presently subject to or potentially subject to inundation by debris flows or deposition of stream-transported sediments."

No landslide hazards are identified on or adjacent to the site in the King County Sensitive Areas Map Folio. However, portions of the existing piped inflow and outflow in the easternmost portion of the site have been identified as a potential landslide area, as shown on Figure 3.1-5.



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Drawing entitled "KING COUNTY HOUSING AUTHORITY, VIC. SW ROXBURY & 8TH AVE SW" by Bush, Roed & Hitchings, Inc, dated Nov. 2002, and "Lidar Slope Analysis" dated 02/25/03, and "On-site Slope Analysis" dated 02/07/03, both "Greenbridge–Hope VI Master Plan, King County Housing Authority" by Goldsmith & Associates.

Source: GeoEngineers, Inc.

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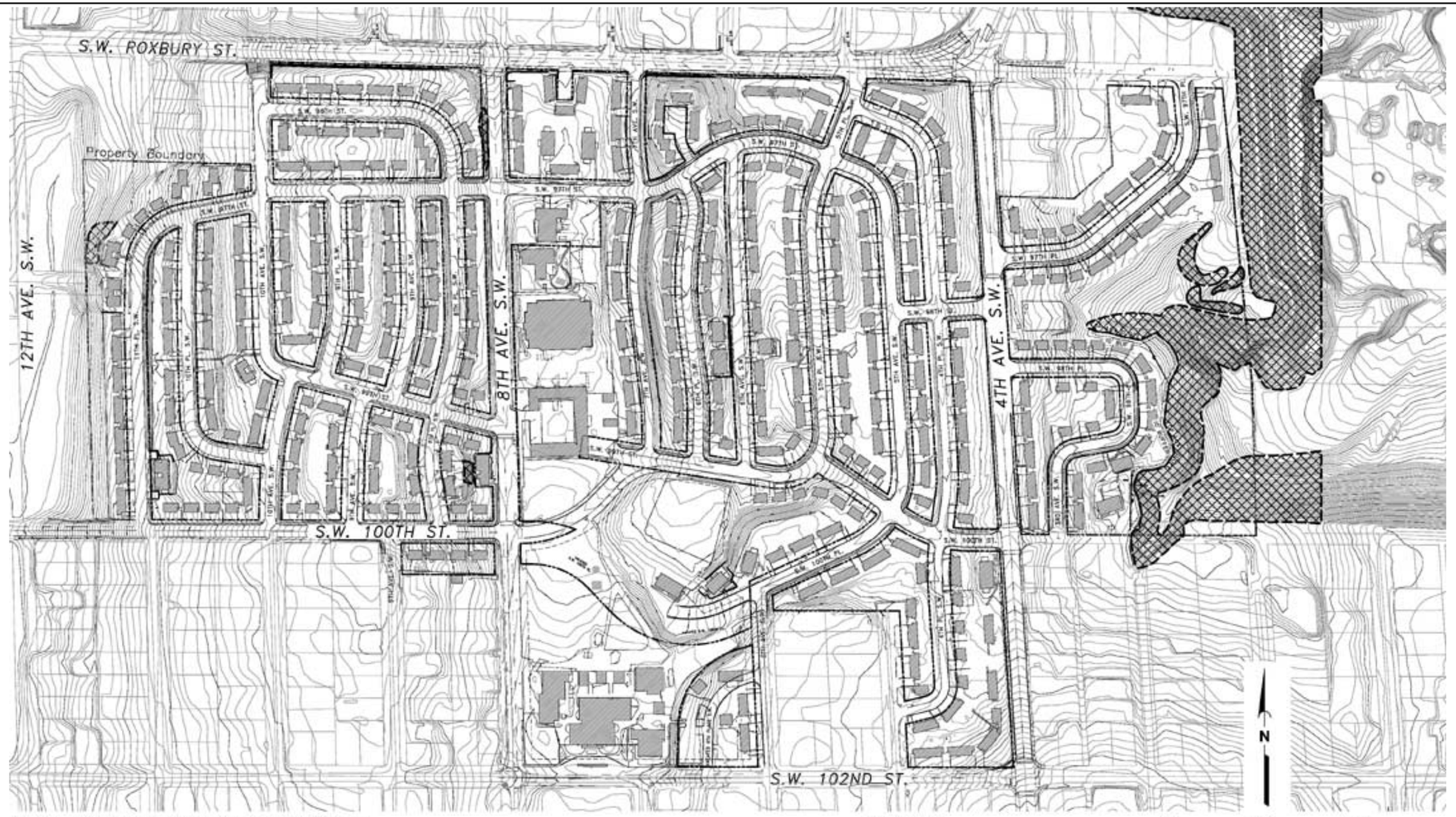
Figure 3.1-4

Erosion Hazards



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Source: GeoEngineers, Inc.

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Figure 3.1-5

Steep Slope and Landslide Hazards

Portions of the drainage swale were identified as a landslide hazard area because the slopes are greater than 40 percent and shallow sloughing is present within the swale. The sloughing occurs below a sharp break in slope about 15 to 25 feet above the bottom of the swale, near the eastern site boundary.

Seismic Hazards

Seismic hazard areas are defined as those areas subject to severe risk of earthquake damage as a result of seismically induced settlement or liquefaction, usually associated with areas underlain by cohesionless soils of low density and shallow groundwater.

The Puget Lowland area is a seismically active region that has experienced thousands of earthquakes in historical time. Based on past earthquake activity, the Uniform Building Code assigns the Puget Lowland region a Zone 3 rating for seismic activity on a scale of 1 (lowest) to 4 (highest). Seismic hazards represent risk of injury or damage to humans and property resulting directly from earthquakes. Seismic hazard mechanisms include surface fault rupture, ground shaking and associated ground failure such as liquefaction and landsliding. Liquefaction is the loss of strength by loose, saturated soil when subjected to vibration or shaking.

Recent maps of the east-west trending Seattle fault zone indicate that the nearest fault is located approximately 0.5 to 1 mile north of the site. Recent scientific articles suggest that fault movement may have occurred between 500 and 1,500 years ago. The available data indicate that surface fault rupture is unlikely to occur at the site.

Historical evidence collected by the U.S. Geological Survey suggests that the number and location of seismically triggered landslides are related to other known factors affecting landsliding, such as material type, slope inclination, and groundwater conditions. Therefore, areas at risk for seismically triggered landslides are the same areas identified as landslide hazard areas. However, the U.S. Geological Survey data indicate that seismic triggering of landslides is less common in the Pacific Northwest than in other seismically active areas partly because of the typically greater focus depth of earthquakes in the Pacific Northwest.

No seismic hazard areas are identified on or adjacent to the site in the King County Sensitive Areas Map Folio. However, areas at risk from seismically induced landslides include the landslide hazard area shown in Figure 3.1-5. In addition, a moderate risk of liquefaction occurs in thin layers of clean to silty fine to medium sands within the fill and the ice-contact deposits in the vicinity of the community buildings.

Coal Mine Hazards

Coal mine hazard areas are defined as those areas directly underlain by or affected by coal mine workings such as adits, tunnels, drifts or air shafts. The principal issues regarding public safety and property damage related to abandoned coal mines include (1) sinkholes and related gas emissions or concentrations, (2) trough subsidence, and (3) coal spoils. The King County Sensitive Areas Map Folio shows no coal mine hazard areas in the vicinity of the site.